Practical works – n^{o}1

Signals

• **Exercice 1** – *Deterministic signals*

1.1 Considering the Dirac function corresponding to Equation (1), write a `matlab` function `Dirac` to define a discrete signal of length `N` and containing the Dirac function at the position `n` ($\delta(k-n)$). Verify inside the function that $n \in [1, N]$ and display a warning if it is not the case.

$$\delta(k) = \begin{cases} 1 & \text{if} \quad k = 0 \\ 0 & \quad\text{elsewhere} \end{cases} \tag{1}$$

By default n and N should be equal to 0 and 20, respectively. Plot the signal for $n = 10$. Dont forget caption and title for your plot.

1.2 Considering the step function H corresponding to Equation (2), write a `matlab` function `step` to define a discrete signal of length `N` and containing the value of the step function shifted at the position `n` ($H(k-n)$). Verify inside the function that $n \in [1, N]$ and display a warning if it is not the case.

$$H(k) = \begin{cases} 1 & \text{if} \quad k \geq 0 \\ 0 & \quad\text{elsewhere} \end{cases} \tag{2}$$

By default n and N should be equal to 0 and 20, respectively. Plot the signal for $n = 10$. Dont forget caption and title for your plot.

1.3 Considering the ramp function $P(k)$ corresponding to Equation (3), write a `matlab` function `ramp` to define a discrete signal of length `N` and containing the values of the ramp function shifted at the position `n` with a slope `a` : $a.P(k-n)$. Verify inside the function that $n \in [1, N]$ and display a warning if it is not the case.

$$P(k) = \begin{cases} k & \text{if} \quad k \geq 0 \\ 0 & \quad\text{elsewhere} \end{cases} \tag{3}$$

By default a, n and N should be equal to 1, 0, and 20, respectively. Plot the signal for $a = 2$ and $n = 10$. Dont forget caption and title for your plot.

1.4 Considering the geometric function $G(k)$ corresponding to Equation (4), write a `matlab` function `geo` to define a discrete signal of length `N` and containing the values of the geometric function shifted at the position `n` ($G(k-n)$). Verify inside the function that $n \in [1, N]$ and display a warning if it is not the case.

$$G(k) = \begin{cases} a^k & \text{if} \quad k \geq 0 \\ 0 & \quad\text{elsewhere} \end{cases} \tag{4}$$

By default a, n and N should be equal to 1, 0, and 20, respectively. Plot the signal for $a = 2$ and $n = 10$. Dont forget caption and title for your plot.

1.5 Considering the box function $B(k)$ corresponding to Equation (5), write a `matlab` function `box` to define a discrete signal of length `N` and containing the values of the box function shifted at the position `n` with a half-width `a` : $B_a(k-n)$. Verify inside the function that $n \in [1+a, N-a]$ and display a warning if it is not the case.

$$B_a(k) = \begin{cases} 1 & \text{if} \quad -a \leq k \leq a \\ 0 & \quad\text{elsewhere} \end{cases} \tag{5}$$

By default a, n and N should be equal to 1, 10, and 20, respectively. Plot the signal for $a = 3$ and $n = 10$. Dont forget caption and title for your plot.

1.6 Write a `matlab` function sin_{fn} to define a discrete signal of length `N` and containing the values of $sin(2\pi fnT_s)$ where the parameters are the frequency of the wave, the number of periods, and the sampling frequency.

Plot the single preiod signal with frequency of 10 Hertz and sampling frequency of 100 Hertz.
Repeat the plotting for the singal with a $f = 10Hz$ and $T_s = 1000$ and periods $= 2$.
Once again plot the signal with $f = 10$, $T_s = 30$ over 2 periods.

• **Exercice 2** – *Random signals*

2.1 Generate an observation x_n 1000 of the normal/gaussian random process $\mathcal{N}$. Plot the histogram of these data as well as the theoretical distribution.

Increase the number of samples to 10000 and repeat the experiment. Discuss.

2.2 Same question with the uniform law of the random process $\mathcal{U}$ and an observation x_u.

2.3 Compute the autocorrelation of the two observations and plot them. Are these noises "white" ? Conclusion ?

2.4 Generate three binary random signals s_1, s_2, s_3 thanks to the instruction $round(rand(1, 50))$. Generate a whole signal s containing these signals at different shifts. Compute the cross-correlation between the whole signals and s_1, s_2, s_3. Comments the results.